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```python
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
from keras.utils import np_utils
from tensorflow.keras.datasets import mnist
from tensorflow.keras.models import Sequential
from tensorflow.keras.layers import Conv2D, Dense, Flatten
from tensorflow.keras.optimizers import Adam
from tensorflow.keras.models import load_model
from PIL import Image, ImageOps
import numpy
```

```python
(X_train, y_train), (X_test, y_test) = mnist.load_data()
```

```python
print(X_train.shape)
print(X_test.shape)
```

```
(60000, 28, 28)
(10000, 28, 28)
```

```python
X_train[0]
```

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```
        0,   0],
 [  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
    0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
    0,   0],
 [  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
    0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
    0,   0],
 [  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   3,
   18,  18,  18, 126, 136, 175,  26, 166, 255, 247, 127,   0,   0,
    0,   0],
 [  0,   0,   0,   0,   0,   0,   0,   0,  30,  36,  94, 154, 170,
  253, 253, 253, 253, 253, 225, 172, 253, 242, 195,  64,   0,   0,
    0,   0],
 [  0,   0,   0,   0,   0,   0,   0,  49, 238, 253, 253, 253, 253,
  253, 253, 253, 253, 251,  93,  82,  82,  56,  39,   0,   0,   0,
    0,   0],
 [  0,   0,   0,   0,   0,   0,   0,  18, 219, 253, 253, 253, 253,
  253, 198, 182, 247, 241,   0,   0,   0,   0,   0,   0,   0,   0,
    0,   0],
 [  0,   0,   0,   0,   0,   0,   0,   0,  80, 156, 107, 253, 253,
  205,  11,   0,  43, 154,   0,   0,   0,   0,   0,   0,   0,   0,
    0,   0],
 [  0,   0,   0,   0,   0,   0,   0,   0,   0,  14,   1, 154, 253,
   90,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
    0,   0],
 [  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0, 139, 253,
  190,   2,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
    0,   0],
 [  0,   0,   0,   0,   0,   0,   0,   0,   0,   0,  11, 190,
  253,  70,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,   0,
    0,   0],
```

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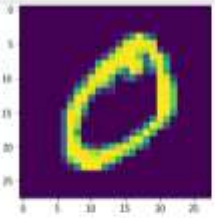

```
X_train = X_train.reshape(60000, 28, 28, 1).astype('float32')
X_test = X_test.reshape(10000, 28, 28, 1).astype('float32')
```

```
number_of_classes = 10
Y_train = np_utils.to_categorical(y_train, number_of_classes)
Y_test = np_utils.to_categorical(y_test, number_of_classes)
```

```
Y_train[0]
```

```
array([0., 0., 0., 0., 0., 1., 0., 0., 0., 0.], dtype=float32)
```

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```
 8.04822832e-07 8.00110600e-08 3.81971218e-08 1.75585291e-09
 2.33875442e-04 2.70559673e-13]
[1.00000000e+00 1.73946696e-20 6.28064371e-12 7.65830914e-19
 8.29306490e-15 9.45817106e-10 1.81072830e-11 5.54238645e-15
 3.84094459e-15 8.55031066e-11]]
```

```
print(numpy.argmax(prediction, axis=1))
print(Y_test[:4])
```

```
[7 2 1 0]
[[0. 0. 0. 0. 0. 0. 0. 1. 0. 0.]
 [0. 0. 1. 0. 0. 0. 0. 0. 0. 0.]
 [0. 1. 0. 0. 0. 0. 0. 0. 0. 0.]
 [1. 0. 0. 0. 0. 0. 0. 0. 0. 0.]]
```

```
model.save("model.h5")
```

```
model=load_model("model.h5")
```

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